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THE USE OF MOTIVATIONAL FILMS TO FAVORABLY CHANGE THE ATTITUDES OF HIGH SCHOOL STUDENTS TOWARD SCIENCE AND SCIENTISTS.

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A STUDY WAS MADE TO DETERMINE THE EXTENT TO WHICH THE ATTITUDES OF A SELECTED GROUP OF HIGH SCHOOL STUDENTS TOWARD SCIENCE AND SCIENTISTS COULD BE FAVORABLY CHANGED BY VIEWING 10 "HORIZONS OF SCIENCE" FILMS. AN EXPERIMENTAL GROUP OF 122 STUDENTS AND A CONTROL GROUP OF 138 STUDENTS WERE ROUGHLY EQUIVALENT. BOTH GROUPS WERE PRETESTED WITH THE "ALLEN ATTITUDE SCALE" AND THE "FACTS ABOUT SCIENCE TEST." THE EXPERIMENTAL GROUP SAW ONE FILM PER WEEK FOR 10 WEEKS. EACH GROUP WAS AGAIN TESTED WITH THE SAME TWO TESTS. PRETEST AND POST-TEST DIFFERENCES WERE EXPECTED TO INDICATE THE EFFECTS OF FAMILIARITY WITH THE TESTS AND OF EXPERIENCES RELATED TO THE PASSAGE OF TIME. NO STATISTICALLY SIGNIFICANT DIFFERENCES WERE OBTAINED FOR EITHER GROUP ON THE "ALLEN ATTITUDE SCALE," YET, CHANGES ON SPECIFIC TEST ITEMS INDICATED ATTITUDES OF STUDENTS IN EACH GROUP WERE CHANGING. NO SIGNIFICANT DIFFERENCES WERE DISCOVERED FOR THE EXPERIMENTAL GROUP ON THE "FACTS ABOUT SCIENCE TEST," WHICH MEASURES UNDERSTANDING OF SCIENCE AS A SOCIAL INSTITUTION. OTHER MEASURES ALSO INDICATED THAT THE FILMS PRODUCED NO APPRECIABLE CHANGES IN THE EXPERIMENTAL GROUP'S RESPONSE. UNFAVORABLE CHANGES WERE INDICATED FOR THE CONTROL GROUP ON THE "FACTS ABOUT SCIENCE TEST." FURTHER RESEARCH WAS RECOMMENDED. (JC)

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Science Specialist

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INTRODUCTION

In the years ahead, the rate of progress of civilization and perhaps the economic and political survival of nations will depend upon the quality and number of scientists and technicians produced. Moreover, contributions made by those engaged in scientific pursuits will be directly related to decisions made by non-scientific personnel in administrative and policy making positions. Voters and their elected representatives will make critical decisions which will determine the amount of financial support given to basic research and to the education of future scientists.

The public, scientists, and educators have become increasingly concerned with science education. Frequently, these concerns have been manifested in criticism of the public school system. Numerous proposals have been forwarded in attempts to cause greater numbers of students to enter scientific and technological professions. Even though scientists and professional educators have disagreed at times concerning proposed methods for improving science education, both groups have recognized the need for developing a better understanding of the nature of science itself for the general education of all students.

Related Research

A limited number of studies have been made to determine the attitudes of high school students toward the scientific endeavor and toward science as a profession. In exploring the aptitudes and attitudes of high school

students toward occupations, Baker, Heath, Stoker and Remmers[1] found a lack of information about scientists and the work of scientists among the respondents. Significant numbers of the students responding expressed unfavorable attitudes toward science as a profession.

Mead and Metraux[2] revealed in their study for the American Association for the Advancement of Science that high school students held a positive official image of scientists but that the students' personal image of scientists was negative. Allen's[3] study of the attitudes of high school seniors in New Jersey indicated that these students expressed attitudes generally favorable toward science and technology but that substantial numbers of the group held unfavorable attitudes.

As long as large groups of students hold unfavorable images and attitudes concerning the scientist and his work, the number of students entering professions in engineering and science will not increase appreciably. Regardless of how rigorous science is made at the high school level, regardless of additional science requirements for college entrance, children will choose science careers and will support scientific endeavors only if they hold positive personal attitudes toward science and scientists. The need for exploratory work in changing the attitudes of high school students is evident.

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[1]P. C. Baker, R. W. Heath, H. W. Stoker, and H. H. Remmers, "Physical Science Aptitude and Attitudes Toward Occupations," The Purdue Opinion Panel Poll, No. 45. (Lafayette, Indiana: Division of Educational Reference, Purdue University, July, 1956.)

[2]Margaret Mead and Rhondo Metraux, "Images of the Scientist Among High School Students--A Pilot Study," Science, 126: 384-390, August 30, 1957.

[3]Hugh Allen, Jr., Attitudes of Certain High School Seniors Toward Science and Scientific Careers (New York: Bureau of Publications, Teachers College, Columbia University, 1960.)

THE PROBLEM

The purpose of this investigation was to determine, if possible, to what extent the attitudes of a selected group of high school students could be favorably changed toward science and scientists as a result of viewing ten motivational films. Specific questions to be answered were:

1. Do these films significantly change attitudes as measured by the Allen Attitude Scale?[4]
2. Do these films favorably change the students' understanding of science as a social institution as measured by the Facts About Science Test?[5]
3. Do these films favorably change the students' knowledge of scientists as an occupational group as measured by the Facts About Science Test?[6]
4. Is there a significant difference between the change in attitudes of students who elect science courses and those who take only the required courses?
5. Are changes in attitude related to the student's grade level?
6. Is there any significant difference between the change in attitudes of boys and of girls?

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[4] Ibid, pp. 47-52.

[5] Glen Stice, The Facts About Science Test, (Princeton, New Jersey: Educational Testing Service).

[6] Ibid.

In addition to these specific questions, each item on the Allen Attitude Scale and on the Facts About Science Test was examined to determine the significance, if any, of the difference between pretest and posttest responses.

PROCEDURE

Experimental Design

The experimental group was composed of two sections of twelfth grade physics, two sections of eleventh grade chemistry and two sections of tenth grade biology. The control group was composed of one physics section and one sociology section at the twelfth grade level, one section of chemistry and one section of American History at the eleventh grade level, and two sections of biology at the tenth grade level. All physics sections were taught by one teacher. Similarly, all chemistry sections were taught by one teacher. General biology was a required course for tenth grade students so it was not possible to include a non-science section in the control group. Two teachers taught two sections each of biology. Each biology teacher taught one experimental section and one control section. For purposes of analysis each section was considered as a subgroup. The experimental group was composed of six subgroups as was the control group giving a total of twelve subgroups.

The Allen Attitude Scale and the Facts About Science Test were administered to all students as pretests and posttests. Other student information was obtained with a questionnaire.

All students were pretested. Students in the experimental group then viewed the ten Horizons of Science[7] films at weekly intervals. The films

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[7]Horizons of Science Film Program (Princeton, New Jersey: Educational Testing Service.) Film titles were: "Visual Perception," "The Worlds of Dr. Vishnias," "Exploring the Edge of Space," "Thinking Machine," "The Mathematician and the River," "New Lives for Old," "Project Mohole," "The Realm of the Galaxies," "The Flow of Life," and "Neutrons and the Heart of Matter."

were shown in the school auditorium to all students in the experimental group. Posttests were administered to the film and non-film groups after the tenth film was shown.

Each student's response on each item on the Allen Attitude Scale was transferred to IBM cards. The Facts About Science Test was scored and each student's score on scale 1, scale 2, and the total score was punched on IBM cards. All other statistical information obtained for each student was recorded on punch cards.

Data obtained with the Allen Attitude Scale was first analyzed by obtaining the Pearson product-moment coefficient of correlation between the students' responses and the judges' scale scores as determined by Allen.[8] Coefficients of correlation were obtained for each of the twelve subgroups on the pretest and the posttest. Appropriate tests, chi square and F, were run to determine the significance of the difference between coefficients of correlation. A t-test was also run on each item of the Allen Attitude Scale to determine the attitudes that were significantly changed.

Analysis of variance was used to compare the pretest means of student scores on the Facts About Science Test of the subgroups and the experimental and control groups. The t-test was used to determine the significance of the difference between pretest and posttest means for each of the 12 subgroups. Chi square was used to determine the significance of change on each item of the Facts About Science Test.

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[8]Allen, op. cit., pp. 8-9.

ANALYSIS OF DATA

The Facts About Science Test

Since the experimental and control groups were only roughly comparable it was necessary to test the null hypothesis that the groups could have been drawn from a common population. Subgroups were chosen in a manner that would permit comparisons concerning the effects of the films, grade level, science courses, and the teacher upon student attitudes. The major hypothesis being tested was that there were no significant differences between the attitude changes of the experimental and the control groups.

Table I gives the number of students in each subgroup. Students in sections I and II of grades 11 and 12 viewed the films and took the same science course from the same teacher. Students in section III of grades 11 and 12 did not see the films but did take the same science course from the same teacher as did their counterparts in the experimental group. Students in section IV of grades 11 and 12 were not enrolled in science courses. Since biology was a required course in the 10th grade, the subgroups were selected so subgroups 11 and 13 were taught by one teacher and subgroups 12 and 14 were taught by another teacher.

Experimental and Control Groups. An analysis of variance was used to test the null hypothesis that the pretest means of the twelve subgroups could have been drawn from the same population. Correction was made for disproportionality among the groups. Results of this analysis are shown in Table 2.

The values for F were found to be significant beyond the one per cent level, necessitating the rejection of the hypothesis of a common population.

Table 1

The Twelve Subgroups

	Experimental		Control		Totals
	Section I	Section II	Section III	Section IV	
Grade 10	Biology (11) n = 30	Biology (12) n = 18	Biology (13) n = 28	Biology (14) n = 31	N = 107
Grade 11	Chemistry (21) n = 23	Chemistry (22) n = 19	Chemistry (23) n = 19	American History (24) n = 18	N = 79
Grade 12	Physics (31) n = 16	Physics (32) n = 16	Physics (33) n = 17	Sociology (34) n = 25	N = 74
Totals	N = 69	N = 53	N = 64	N = 74	
	N_t = 122		N_t = 138		N_t = 260

Table 2

Analysis of Variance of Facts About Science
Pretest Scores With Means Adjusted for Disproportionality

	df	Sums of Squares		Mean Square	F
		Unadjusted	Adjusted		
Grade	2	861.80	882.36	441.18	7.0808
Section	3	3,216.90	3,237.46	1,079.15	17.2955
Interaction	6	1,307.85	1,287.29	214.55	3.4386
Within	248	15,473.99		62.40	
Total	259	20,860.54			

Since the null hypothesis was rejected valid comparisons could not be made between experimental and control groups or among grades. However, the significance of the difference between the means of pretest and posttest scores could be made for any selected group since each student was essentially being matched with himself.

Scale 1 of the Facts About Science Test is designed to measure the "understanding of science as an institution" while scale 2 measures "knowledge of scientists as an occupational group." The null hypothesis that there was no significant difference between the pretest and posttest means of the experimental group was found to be tenable for scale 1 and for scale 2. The null hypothesis of no significant difference between the pretest and posttest means of the control group was rejected at the 0.1 per cent level for scale 1 and the 2 per cent level for scale 2. The direction of attitudinal change for the experimental group was positive while the control groups attitudes became significantly worse.

Tests to determine the significance of the difference between the pretest and the posttest total scale score means revealed no differences for students in the experimental group who planned to elect science courses in the future. No significant differences were obtained for students in the experimental group not planning to elect future science courses. Changes for both groups were in a positive direction.

A significant difference at the 0.1 per cent level was found between the pretest and posttest means of students in the control group who had taken elective science courses. No significant difference was found between the pretest and posttest means of students in the control group who had taken elective science courses. No significant difference was found between the means for students in the control group who had not elected science

Table 3

Summary of T-Tests for Significant Differences Between the Pretests and Posttests of the Facts About Science Test

Group	N	Scale	Pretest Mean	Posttest Mean	t	Significance Level
Experimental	122	1	24.541	24.631	.230	
Control	138	1	22.768	21.072	-4.297	.001
Experimental	122	2	25.811	25.951	.300	
Control	138	2	24.101	22.877	-2.463	.02
Plans to Elect Science Courses (Experimental)	104	Total	52.058	52.288	.289	
No Plans to Elect Science Courses (Experimental)	18	Total	40.111	40.833	.452	
Have Elected Science Courses (Control)	91	Total	48.121	44.670	-3.347	.001
Have Not Elected Science Courses (Control)	47	Total	44.404	42.489	-1.524	
Males (Experimental)	72	Total	51.347	50.444	- .939	
Females (Experimental)	50	Total	48.780	50.820	1.974	.05 +
Males (Control)	81	Total	46.938	43.272	-3.419	.001
Females (Control)	57	Total	46.737	44.860	-1.559	

courses. Attitudinal changes for both of these groups were in a negative direction.

No significant difference was obtained between the pretest and posttest means of males in the experimental group. The difference for females approached but did not reach significance at the 5 per cent level. Direction of change for the boys was negative while that for the girls was positive.

When the control group was subdivided into males and females, a significant difference at the 0.1 per cent level between the pretest and posttest means was found for males, while the t-values for females indicated no significant difference. The direction of change for both groups was negative. These t-tests are summarized in Table 3.

Subgroups. A t-test was also made for each subgroup. The null hypothesis being tested for each subgroup was to the effect that no significant difference exists between the pretest and posttest means. There was no significance between the means for either of the two experimental biology subgroups, 11 and 12, though the change was in a positive direction. A significant difference was recorded for subgroup 13 of the biology control group. Attitudes became worse in this group. No significant difference was obtained in biology subgroup 14 of the control group but the direction of change was positive.

The direction of change for each of the two experimental subgroups in chemistry, 21 and 22, was negative. The change for subgroup 22 was significant at the 5 per cent level. The direction of change for the chemistry control subgroup 23 was positive while that of the American History control subgroup was negative. No significant differences were obtained for either of these two subgroups.

Subgroup 31 of the physics experimental group experienced a positive change that was significant at the one per cent level. The difference between the means of the physics experimental subgroup 32 was negative and non-significant. The two control subgroups, physics 33 and sociology 34, produced t-values indicating significance at the 5 per cent and one per cent levels respectively. The direction of change was negative for both groups. A summary of this data is included in Table 4.

Test Items. A graphic item counter was used to obtain the number of correct and incorrect responses for each item on each of the two scales. A contingency table was set up as follows:

	Right	Wrong	Totals
Pretest	A	B	A & B
Posttest	C	D	C & D
Totals	A & C	B & D	N

Chi square was calculated for each item by using the following formula based upon the contingency table:

$$\chi^2 = \frac{N(AD - BC)^2}{(A+B)\ (C+D)\ (A+C)\ (B+D)}$$

The null hypothesis being tested for each item was that there was no significant difference between the pretest and posttest responses to the items. Significant differences at and beyond the 5 per cent level were recorded as indicated in Tables 5 and 6.

Table 4

Summary of T-Tests for Differences Between Pretest and Posttest Means of Each Subgroup on the Facts About Science Test

Course	Group	Mean (Pre)	Mean (Post)	t	Significance
Biology (11)	Ex.	49.8666	51.3666	1.0400	
Biology (12)	Ex.	39.3888	41.1111	.9168	
Biology (13)	Con.	50.1428	45.7500	-2.6240	.05
Biology (14)	Con.	44.1612	46.1290	1.7272	
Chemistry (21)	Ex.	57.4347	56.3913	- .5562	
Chemistry (22)	Ex.	51.0000	46.3684	-2.6708	.05
Chemistry (23)	Con.	47.8947	47.7368	- .1168	
American History (24)	Con.	45.4444	42.4444	-1.3622	
Physics (31)	Ex.	54.8750	60.3125	3.4277	.01
Physics (32)	Ex.	47.6875	46.8125	- .8443	
Physics (33)	Con.	49.8235	43.5882	-2.2806	.05
Sociology (34)	Con.	44.7200	37.5600	-3.1321	.01

Table 5

A Comparison of Pretest and Posttest Responses
for Items on Scale 1 of the Facts About Science Test

N=142 Experimental Group						N=154 Control Group					
Question No.	Number Right Pretest	Number Right Posttest	Chi Square	Significance	Sign	Question No.	Number Right Pretest	Number Right Posttest	Chi Square	Significance	Sign
5	80	60	5.634	.02	-	5	82	52	11.888	.01	-
14	52	74	6.904	.01	+	14	44	49	**	**	
31	115	107	**	**		31	122	100	7.808	.01	-
35	106	124	7.408	.01	+	35	112	108	**	**	
48	109	108	**	**		48	117	99	5.021	.05	-
64	124	125	**	**		64	138	125	4.398	.05	-
65	127	127	**	**		65	136	118	7.275	.01	-
66	101	109	**	**		66	113	90	7.644	.01	-
69	124	126	**	**		69	131	111	7.713	.01	-
74	122	122	**	**		74	124	109	3.965	.05	-

Table 6

A Comparison of Pretest and Posttest Responses
for Items on Scale 2 of the Facts About Science Test

N-142 Experimental Group						N-154 Control Group					
Question No.	Number Right Pretest	Number Right Posttest	Chi Square	Significance	Sign	Question No.	Number Right Pretest	Number Right Posttest	Chi Square	Significance	Sign
13	30	37	**	**		13	20	33	3.851	.05	+
38	61	92	13.616	.01	+	38	63	90	9.467	.01	+
42	81	107	10.637	.01	+	42	86	107	6.110	.02	+
51	76	97	6.522	.02	+	51	84	92	**	**	
52	66	58	**	**		52	71	54	3.891	.05	-
59	105	98	**	**		59	113	91	7.026	.01	-
61	36	55	5.837	.02	+	61	55	42	**	**	
75	119	118	**	**		75	130	111	6.885	.01	-
80	118	109	**	**		80	118	88	13.192	.01	-

The Allen Attitude Scale

Student responses on the Allen Attitude Scale were tabulated on each of the 95 items for each of the 12 subgroups. An agreement response consisting of the sum of complete agreement and partial agreement responses was then obtained for each item. A disagreement response was obtained in a similar manner for each item. The Pearson product-moment coefficient of correlation between the students' agreement responses, and the judges' scale scores, as determined by Allen,[9] was calculated for each group. The process was repeated for disagreement responses. These coefficients of correlation are recorded in Tables 7 and 8.

Experimental and Control Groups. In order to make comparisons between the experimental and control groups, it was first necessary to test the probability that these coefficients of correlation for the pretest might have been drawn from a common population. The coefficients of correlation were transformed into Z-values and chi square was computed from the following formula:

$$\chi^2 = \Sigma[z^2(N-3)] - \frac{[\Sigma z(N-3)]^2}{\Sigma(N-3)}$$

Chi square for pretest agreement was found to be 0.640 and pretest disagreement gave a value of 1.456. Both of these values are much smaller than the tabled value of 19.675 required for significance at the 5 per cent level for 11 degrees of freedom. Therefore the hypothesis of a common parent population was tenable.

A test of significance of the difference between the pretest and posttest coefficients of correlation was run by calculating F from the

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[9] Ibid.

Table 7

Correlations Between Students' Responses and
the Judges' Scale Scores for the Experimental Group

Course	Agreement			Disagreement			N
	Pretest r1	Posttest r2	r12	Pretest r1	Posttest r2	r12	
Biology (11)	.7372	.7456	.9681	-.7685	-.7780	.9618	30
Biology (12)	.6837	.6746	.8679	-.7206	-.6699	.8607	18
Chemistry (21)	.7718	.7757	.9725	-.7779	-.7797	.9715	23
Chemistry (22)	.7352	.7407	.9563	-.7557	-.7653	.9355	19
Physics (31)	.7739	.7806	.9529	-.7930	-.7859	.9559	16
Physics (32)	.7405	.7863	.9246	-.7446	-.8093	.9168	16
Experimental Group	.7053	.7196	.9496	-.7352	-.7411	.9435	122

Table 8

Correlations Between Students' Responses and the Judges' Scale Scores for the Control Group

Course	Agreement			Disagreement			N
	Pretest r1	Posttest r2	r12	Pretest r1	Posttest r2	r12	
Biology (13)	.7548	.7682	.9674	-.7572	-.7894	.9718	28
Biology (14)	.7234	.7416	.9400	-.7428	-.7615	.9436	31
Chemistry (23)	.7135	.7381	.9368	-.7216	-.7414	.9361	19
American History (24)	.6981	.6933	.9085	-.7427	-.6948	.8766	18
Physics (33)	.7136	.7738	.9345	-.7261	-.7942	.9487	17
Sociology (34)	.7230	.7294	.9304	-.7582	-.7553	.9141	25
Control Group	.6893	.7069	.9437	-.6878	-.7148	.9432	138

formula developed by Hotelling and referred to by Wert, Heidt and Ahmann.[10]

$$F_{1,\ N-3} = \frac{(r_{y1} - r_{y2})^2 \quad (N-3)(1+r_{12})}{2(1-r^2_{12}-r^2_{y1}-r^2_{y2}+2r_{12}r_{y1}r_{y2})}$$

Values obtained for F were as follows:

Total Experimental Group

F = 0.478 (Agreement

F = 0.068 (Disagreement)

Total Control Group

F = 0.510 (Agreement)

F = 1.228 (Disagreement)

These values were far below the tabled value for significance at the 5 per cent level. The null hypothesis that there were no significant differences between the pretest and posttest scores of either the experimental or the control group was tenable.

Subgroups. Inspection of the difference between the pretest and posttest coefficients of correlation for each of the subgroups revealed relatively large differences for groups 33, 32, 12 and 41. Agreement and disagreement F-values were determined for each of these groups. The difference between the pretest and posttest coefficients of correlation for disagreement of group 33 was found to be significant beyond the one per cent level, (F = 11.501). Significant differences beyond the 5 per cent level were found for the agreement coefficients of correlation of group 33 and the disagreement coefficients of correlation for group 32. These values were F = 6.355 and F = 6.709 respectively.

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[10]James E. Wert, Charles O. Neidt and J. Stanley Ahmann, Statistical Methods in Educational and Psychological Research (New York: Appleton-Century-Crofts, Inc., 1954), p. 299.

Test Items. Individual test items were investigated to determine the significance of the difference between the pretest and posttest responses. Arbitrary numerical values of 1, 2, 3, 4 and 5 were assigned to complete agreement, partial agreement, neutral, partial disagreement and total disagreement responses respectively. Complete agreement with a scale item would be indicated by 1, complete disagreement by 5. A t-test was then run for each item, using the following formula:[11]

$$t = \frac{\frac{\Sigma D}{N}}{\sqrt{\frac{\Sigma D^2 - \frac{(\Sigma D)^2}{N}}{N(N-1)}}}$$

The null hypothesis being tested for each item was that there was no significant difference between the pretest and posttest responses.

Significant changes, at or beyond the 5 per cent level, were recorded on 13 statements for the experimental group. These statements are listed below. Values of 1.98, 2.36 and 2.62 are required for significant differences for 5 per cent, 2 per cent and one per cent, respectively, when N is equal to 130.

Changes were significant, at or beyond the 5 per cent level, on 19 items for the control group. T-values of 1.98, 2.35 and 2.61 correspond to 5 per cent, 2 per cent and one per cent levels of significance when N is equal to 145.

Significant attitude change toward greater agreement with the statement was found on the following items for the control group:

80. Public interest in science is essential to the maintenance of scientific research. (t = -3.685)

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[11] Ibid., p. 141.

60. Science has done little for the average citizen. (t = -3.209)

83. American scientists are largely responsible for our country's status among nations. (t = -2.946)

47. The winning of the esteem of his associates is one of the main incentives for the scientist. (t = -2.943)

6. Science and technology are essential to the development of present day cultures. (t = -2.938)

11. The President's cabinet should be enlarged to include a Secretary of Science. (t = -2.741)

27. The monetary compensation of a Nobel Prize Winner in Physics should be at least equal to that given popular entertainers. (t = -2.623)

68. The average American home discourages girls from scientific careers. (t = -2.595)

40. Maintenance of scientific work is essential to national survival. (t = -2.589)

88. The modern world is dominated by science. (t = -2.524)

36. To appreciate modern society fully, a person must understand the importance of science. (t = -2.387)

87. The working scientist believes that science is orderly rather than disorderly. (t = -2.206)

24. Scientists possess too much power in our society. (t = -2.014)

44. The free flow of scientific information among scientists is essential to scientific progress. (t = -2.001)

Significant attitude change toward <u>greater</u> <u>agreement</u> with the statement was found on the following items for the experimental group:

60. Science has done little for the average citizen. (t = -3.031)

43. Scientific activity is greatly influenced by culture. (t = -2.817)

11. The President's cabinet should be enlarged to include a Secretary of Science. (t = -2.566)

67. A scientist's life is full of adventure. (t = -2.559)

45. Scientists display an almost irrational attachment for their work. (t = -2.153)

93. The chief reward in scientific work is the thrill of discovery. (t = -2.120)

Significant attitude change toward <u>greater</u> <u>disagreement</u> with the statement was found on the following items for the experimental group:

71. Science helps us to understand our environment. (t = 3.033)

63. Science receives too little serious attention in the mass media. (t = 2.734)

65. The engineer serves a more practical purpose in society than does the research scientist. (t = 2.618)

57. Scientists are communistic. (t = 2.595)

72. Scientific concepts and discoveries often bring about new sociological problems. (t = 2.385)

90. Scientists are often willing to sacrifice the welfare of others to further their own interests. (t = 2.401)

42. Scientific work is boring. (t = 2.190)

Significant attitude change toward <u>greater</u> <u>disagreement</u> with the statement was found in the following items for the control group:

51. The scientist can expect to accumulate little wealth as compensation for his work. (t = 3.108)

1. Science is not sufficiently appreciated by most people. (t = 2.177)

3. Scientists are seldom concerned with their working conditions. (t = 2.136)

4. The development of new ideas is the scientist's greatest source of satisfaction. (t = 2.125)

50. Industrial developments are based more on practical experience than on laboratory research. (t = 2.064)

The plus and minus signs do not signify positive or negative attitude changes. A positive t-value indicates a change toward greater disagreement with the statement while a negative t-value designates a change toward greater agreement with the statement. Since both positive and

negative statements are contained in the scale, each item must be examined to determine whether the change in attitude is in a favorable or in an unfavorable direction.

SUMMARY AND CONCLUSIONS

This study was made to determine the extent to which the attitudes of a selected group of high school students toward science and scientists could be favorably changed by viewing ten Horizons of Science Films. An experimental group of 122 students and a control group of 138 students were established. The groups were roughly equivalent. Both groups were pretested with the Allen Attitude Scale and the Facts About Science Test. The experimental group saw one film per week for ten weeks. Each group was again tested with the same two tests. Pretest and posttest differences for the control groups were expected to indicate the effects of familiarity with the tests and of experiences related to the passage of time.

1. No statistically significant differences were obtained for either group on the Allen Attitude Scale though attitudes improved for each group. Significant differences were obtained for physics section 32 in the experimental group and physics section 33 in the control group. Attitudes for both sections changed favorably. This indicates that some factor other than the films was related to the change. It may be significant that initial attitudes in section 33 were worse than in either of the other two physics sections. Physics 31, the section for which no significant change was recorded, had the highest pretest score of the three physics subgroups. Attitudes for all physics sections were approximately the same on the posttest.

2. There was no significant difference for the experimental group between pretest and posttest scores on scale 1 of the Facts About Science Test which measures the student's understanding of science as a social

institution. A difference, significant at the 0.1 per cent level, was obtained for the control group. The control group's understanding of science as a social institution became worse during this period of time.

3. The difference between the pretest and posttest means of the experimental group on scale 2 of the Facts About Science Test, which measures the student's knowledge of scientists as an occupational group, was not significant. The difference for the control group was significant at the 2 per cent level indicating that the control group's knowledge of scientists as an occupational group became worse.

4. There was no significant change on the Facts About Science Test total score for students in the experimental group who had elected or planned to elect science courses; or for students who had neither taken nor planned to take elective science courses. The understanding of science as a social institution and the knowledge of scientists as an occupational group decreased and was significant at the 0.1 per cent level for students in the control group who had elected science courses. No significant difference was obtained for control group students who had not elected science courses.

5. Change on the Allen Attitude Scale and on the Facts About Science Test showed no significant relationship to grade level.

6. Differences for boys and for girls in the experimental group were not significant for the Facts About Science Test though the positive t-value for the girls closely approached significance at the 5 per cent level. In the control group the negative difference was significant for boys at the 0.1 per cent level. There was no significant difference for girls in the control group.

Subgroups

A positive change significant at the one per cent level for physics 31, and a negative change significant at the 5 per cent level for chemistry 22, were obtained for these two experimental subgroups on the Facts About Science Test. Three of the six control subgroups (biology 13, physics 33 and sociology 34) had negative significant differences between pretest and posttest of 5 per cent, 5 per cent and one per cent, respectively.

Test Items

Changes significant beyond the 5 per cent level were recorded for 13 items in the Allen Attitude Scale for the experimental group while 19 items were significant for the control group. Attitudes became more favorable for both groups on the following statement:

11. The President's cabinet should be enlarged to include a Secretary of Science.

A significantly greater number of students in both groups believed the following statement at posttest time than at pretest time:

60. Science has done little for the average citizen.

Another unfavorable change for the experimental group was recorded on the item which reads as follows:

71. Science helps us understand our environment.

More students disagreed with this statement at posttest time than at pretest time.

Unfavorable changes were recorded on four items in the control group in addition to the unfavorable item that was common to both groups. These items were:

24. Scientists have too much power in our society.

68. The average American home discourages girls from scientific careers.

1. Science is not fully appreciated by most people.

4. The development of new ideas is the scientist's greatest source of satisfaction.

Responses on the remaining significant items were positive, 11 in the experimental group and 14 in the control group.

On the Facts About Science Test seven items were significant beyond the 5 per cent level for the experimental group while 15 items were significant for the control group. Changes on the four remaining items of the experimental group were positive. A positive change was recorded for only one of the 12 remaining items in the control group.

Concluding Statement

Results of this study indicate that the films produced no appreciable changes in the experimental group's responses on the Allen Attitude Scale or on the Facts About Science Test. Significant differences were obtained for isolated subgroups and for specific test items for the experimental group. No significant change for the control group was indicated on the Allen Attitude Scale but unfavorable changes were significant on both scales of the Facts About Science Test. Whether or not students had taken or planned to take science courses was a related factor for the control group but was not significant for the film group. The relationship of sex to attitude change was also significant for the control group. However, grade level was not an influencing factor.

Significant changes on specific test items for both the film and the non-film groups provide evidence that students' attitudes are being changed. The following questions may be raised. What happened during the ten-week period to cause a significant number of students in both groups to believe that "science has done little to help the average citizen," when these

same students did not agree with the statement at pretest time? Similarly, what caused a significant number of students in the experimental group to change their attitudes from agreement with the statement "science helps us to understand our environment" to disagreement? All of the students in the film group were enrolled in science courses and the statements appear to be so obvious that one might assume no special effort is needed in science courses to develop favorable attitudes concerning the two items. Results on these two items indicate that little can be taken for granted in attitude development.

How can no significant change on the Allen Attitude Scale be resolved with a significant negative change on the Facts About Science Test for the control group? Strictly speaking, the Facts About Science Test is not an attitude test but one would hypothesize that accurate knowledge of scientists as an occupational group and an understanding of science as a social institution are basic to favorable attitude formation. If the statistical procedures used are equally discriminating, it would appear that attitudes toward science and scientists are more stable and more difficult to change than are the understanding of science as a social institution and the knowledge of scientists as an occupational group. A cautious statement can be made to the effect that the films either kept the scores from getting worse on the Facts About Science Test for the experimental group or that some factor common to the control group but not to the experimental group was responsible for a significant increase in the number of negative responses from the pretest to the posttest.

Other related studies[12] concerning science interests and attitudes have also indicated that attitudes are difficult to change and

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[12]Robert A. Weisgerber, "Motivation for Science," The Science Teacher, Volume 28, Number 1, February, 1961, pp. 20-23.

some[13] suggest that science interests and attitudes may become worse as time passes. Certainly this area of developing favorable interests and attitudes toward science and scientists is one that needs further investigation.

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[13] W. James Popham and Joseph M. Sadnavitch, The Effectiveness of Filmed Science Courses in Public Secondary Schools (Department of Education and Psychology, Kansas State College of Pittsburg, August, 1960); and A. Cornelia Sheehan, The Interrelationships of Interests and Attitudes and Specified Independent Variables in the Teaching of Natural Science by Television in the Fifth Grade: Unpublished dissertation. (Boston University School of Education, 1960).

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